

California High-Speed Train Project



TECHNICAL MEMORANDUM

Interoperability of Tier III HSR Trainsets with Tier I Operations TM 600.03

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ABSTRACT

This technical memorandum provides information relative to operating California High Speed Train Project's (CHSTP) high speed rail (HSR) trainsets over Tier I railroads. The FRA defines Tier I as maximum operational speed up to 125 mph (201 km/h), intermixing with FRA CFR compliant freight, commuter and intercity rail passenger operations, with grade crossings allowed when operating up to 125 mph (201 km/h).

The CHSTP will operate at revenue service speeds up to 220 mph (354 km/h) within its Dedicated or Shared Corridors where the CHSTP has sole use of a track, and up to 125 mph (201 km/h) in Shared Use track conditions where the CHSTP has joint use of tracks with other passenger trains. The Federal Railroad Administration (FRA) has determined that the CHSTP operating environment falls under the classification of a Tier III railroad. The FRA is developing a series of modified and new regulations, via the Engineering Task Force (ETF), that will govern Tier III operations. The FRA has advised that the CHSTP will have the option to share tracks (e.g. Caltrain and LOSSAN corridors) with conventional commuter rail, intercity rail, and freight rail equipment under Tier I operating requirements provided that there is conformance with Tier III requirements.



1.0 INTRODUCTION

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this memorandum is to provide information on the development of FRA Tier III regulations that will govern the interoperability of CHSTP HSR trainsets over FRA Tier I railroads.

1.2 GENERAL INFORMATION

The CHSTP system has been developed around the premise that the system will procure a nominal 1,312 ft (400 m) trainset, comprised of 2 – 656 ft (200 m) trainsets coupled together, capable of accommodating between 900 – 1000 passengers and traveling at a revenue operating speed of up to 220 mph (354 km/h).

The CHSTP has defined an operating environment in which CHSTP trainsets will operate in Dedicated Corridors, Shared Corridors, and in Shared Use operations as described below.

(1) Dedicated Corridor

CHSTP trainsets will operate in a dedicated right-of-way exclusive from other transportation modes and complying with the “Tier V - HSR Express” operating environment as defined by the *FRA High-Speed Passenger Rail Safety Strategy* published in November 2009. Tier V is now consolidated with Tier III in the RSAC ETF definitions for HSR classifications (see Section 3.2)

(2) Shared Corridors

CHSTP trainsets will operate on dedicated tracks within shared transportation corridors where other rail operations or highways are located adjacent to and in close proximity of (i.e. track centers or distances to traffic lanes that are less than 100 ft (30.5 m)) from the CHSTP track centers. The operating environment within shared corridors will also comply with the “Tier V - HSR Express” operating environment as defined by the *FRA High-Speed Passenger Rail Safety Strategy*. Tier V is now consolidated with Tier III in the RSAC ETF definitions for HSR classifications (see Section 3.2)

(3) Shared Use

CHSTP trainsets may share tracks with other rail operators between San Jose and San Francisco (Caltrain Corridor), and between Los Angeles and Anaheim (LOSSAN Corridor). The CHSTP will comply with the requirements of the “Tier IC – HSR Regional” operating environment within Shared Use corridors as defined by the *FRA High-Speed Passenger Rail Safety Strategy*.

The limits of proposed dedicated and shared corridors and shared use will be confirmed upon completion of the project level environmental approval process.

2.0 DEFINITION OF TECHNICAL TOPIC

None Applicable

3.0 ASSESSMENT / ANALYSIS

3.1 FRA RSAC ENGINEERING TASK FORCE (ETF)

In September 2009, the FRA Railroad Safety and Advisory Committee’s (RSAC) ETF was convened to evaluate rolling stock designs and to develop guidelines that the railroads and the industry could implement to support waiver petitions applicable to existing Tier I FRA Code of Federal Regulations (CFR).

A draft report titled *Technical Criteria and Procedures for Evaluating the Crashworthiness and Occupant Protection Performance of Alternatively-Designed Passenger Rail Equipment for Use in Tier I Service* was issued in May 2010.

These Criteria and Procedures (C&P) were developed in concert with current domestic and international service-proven technology in rail equipment crashworthiness. The C&P presented guidance on crashworthiness and structural elements of trainsets that departed from the



requirements contained in current CFR Tier I regulations. One example is the implementation of collision scenarios, a philosophy embraced in European rolling stock design, to determine minimum train-level design characteristics. The C&P identified requirements that, if adopted, provided an equivalent level of crashworthiness as the current Tier I regulations.

As the number of HSR projects and potential HSR corridors increased, the FRA convened a new ETF focused on developing guidelines for HSR trainsets capable of traveling up to a revenue operating speed of 220 mph (354 km/h), as the current CFRs did not address rolling stock traveling at speeds greater than 150 mph (241 km/h). In addition, the regulations developed for Tier II operations (\leq 150 mph (241 km/h) operating speed) were not appropriate to Tier V trainsets due to the significant restrictions on weight and axle loading. In October 2010, the ETF convened to develop guidelines for Tier V trainsets.

3.2 INTEROPERABILITY

The FRA recognized that there was a potential for Tier V railroads to be interconnected with new and/or existing Tier I railroads, especially to provide cost-effective service to dense urban centers. The CHSTP is a good example of this interconnection between Tier V and Tier I operations. The FRA advised the ETF that due to the potential for interconnection with Tier I railroads, a level of interoperability for the trainsets was necessary. The FRA also advised that Tier V trainset characteristics such as crashworthiness, structural strength, and occupant protection, would need to be compatible with Tier I requirements.

At the January 2011 ETF meeting, the FRA introduced the CFR Tier III classification, which would represent the FRA's highest-speed safety requirements. The Tier III classification replaces the Tier III/Tier IV/Tier V classifications identified in the *FRA High-Speed Passenger Rail Safety Strategy*.

The FRA advised that the Tier III designation is consistent with the need to support operational compatibility with Tier I service.

3.3 TIER I / TIER III

The FRA defines Tier I as follows:

- Maximum operating speed up to 125 mph (201 km/h);
- Intermixing with FRA CFR compliant freight, commuter and intercity rail passenger operations;
- Grade crossings allowed, with specified grade crossing protection, when operating up to 125 mph (201 km/h).

The FRA defines Tier III as follows:

- Maximum operational speed above 125 mph (201 km/h);
- Exclusive right-of-way required above 125 mph (201 km/h);
- No intermixing with freight or non Tier III passenger operation (i.e. Tier I or Tier II operations) at speeds above 125 mph (201 km/h);
- No grade crossings when operating above 125 mph (201 km/h);
- Operationally compatible with Tier I and Tier II equipment at speeds below 125 mph (201 km/h);
- Can operate in a Tier I environment at appropriate Tier I speeds.

The critical attribute of the Tier III classification is the **allowance for Tier III HSR trainsets to operate in a Tier I environment**. The Tier III classification closely resembles the anticipated operating environment for the CHSTP.

The FRA has advised that the CHSTP will have the option to share tracks (e.g. Caltrain and LOSSAN corridors) with conventional commuter rail, intercity rail, and freight rail equipment under Tier I operating requirements provided that there is conformance with Tier III requirements.



The ETF has been guided by this definition, and recent ETF efforts have focused on developing the C&P for Tier III trainsets.

3.4 CRITERIA AND PROCEDURES FOR TIER III TRAINSETS

The ETF has been reviewing international best practices, including crashworthiness requirements and technical capabilities of existing HSR operators and manufacturers. The ETF has evaluated potential accident conditions for a Tier III operating environment, and has developed approaches for mitigating hazards.

Appendix A provides a status of the technical attributes that have been evaluated by the ETF.

4.0 SUMMARY AND RECOMMENDATIONS

4.1 CHSTP RECOMMENDATION

The CHSTP recommends supporting the FRA RSAC ETF with respect to developing a practical technical solution to achieving compatibility and interoperability between dedicated HSR corridors and Tier I operating environments. This is best achieved by identifying technical solutions found in service proven HSR trainset designs that provide a level of safety equivalent to the current Tier I CFRs.

5.0 SOURCE INFORMATION AND REFERENCES

Technical Criteria and Procedures for Evaluating the Crashworthiness and Occupant Protection Performance of Alternatively-Designed Passenger Rail Equipment for Use in Tier I Service Applicable, US Department of Transportation, May 2010

FRA RSAC ETF proceedings, US Department of Transportation, October 2010 – March 2011

6.0 DESIGN MANUAL CRITERIA

None applicable



APPENDIX A**ETF HSR Proceedings Matrix (Rev. May 13, 2011)****Color Key**

Green	= Issue Closed
Yellow	= Issue Pending Closure
Clear	= Issue Open

No.	Description	Approach	Consensus			Comments
			Yes	No	Under Review (Anticipated Completion)	
1a	Collision with Conventional Equipment	Tier I Alt Compliance Criteria	X			Issue was voted on and approved 2/14/2011.
1b	Occupied Volume Integrity	Tier I Alt Compliance Criteria	X			Issue was voted on and approved 2/2011.
1c	Colliding equipment override	Tier I Alt Compliance Criteria	X			Industry advised that the override criteria for colliding equipment was acceptable. Issue was voted on and approved on 3/30/11.
1d	Connected equipment override	Tier I Alt Compliance Criteria	X			Industry advised that the override criteria for connected equipment was acceptable. Issue was voted on and approved on 3/31/11.



1e	Fluid entry inhibition	<p>Bombardier provided a presentation on the industry proposal for fluid entry inhibition. FRA requested clarification relative to fluid entry inhibition. Bombardier advised that the structure ahead of the cab is to be fully sealed with welds. FRA questioned that once CEM modules were exhausted, how would fluid entry be inhibited? FRA suggested an option to crush CEM to exhaustion, or, use grade crossing scenario and then test for sealed structure. The industry is requested to consider this question and advise of proposed performance based requirements.</p> <p>Industry proposed eliminating the 25ksi steel sheet requirement. For Tier III, FRA advised that the structural strength requirement is addressed via the ETF collision scenarios, therefore there is no need to maintain the steel plate requirement.</p> <p><u>Industry to prepare a statement. Potential to consider a projected material approach via simulations to look for fractures and/or separations in the model. An evaluation of the rupture analysis will then be performed to check for apparent leakage.</u></p>			6/16 – 6/17/11	<p>Current CFR language for reference:</p> <p>238.209 Forward end structure of locomotives, including cab cars and MU locomotives</p> <p>The skin covering the forward-facing end of each locomotive shall be:</p> <ul style="list-style-type: none"> (a) Equivalent to a 1/2 inch steel plate with a 25,000 pounds-per-square-inch yield strength material of a higher yield strength may be used to decrease the required thickness of the material provided at least an equivalent level of strength is maintained. (b) Designed to inhibit the entry of fluids into the occupied cab area of the equipment; and (c) affixed to the collision posts or other main vertical structural members of the forward end structure so as to add to the strength of the end structure. <p>(d) As used in this section, the term skin does not include forward-facing windows and doors.</p> <p><i>Note: Section-by-section analysis would clarify: Compliance to be verified via a drawing review. (As is currently done today.)</i></p>
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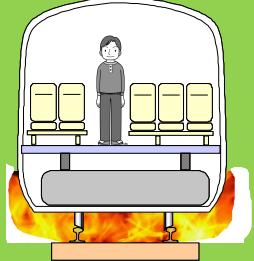


1f	End structure integrity of cab end	Tier I Alt Compliance Criteria	X			Issue was voted on and approved 2/2011.
1g	End (corner) structure integrity of non-cab end	Tier I Alt Compliance Criteria FRA to review submittal and be prepared to respond at the next ETF meeting. No action for industry. <u>FRA</u> to respond to 10x10 loading patch proposal.			6/16 – 6/17/11	Tier I Alt Compliance Criteria to be respected utilizing a 10 x 10 inch (maximum) loading patch. Industry to request FRA consideration to revisit the appropriateness of this requirement relative to CEM trainsets.
1h	Roof integrity	Tier I Alt Compliance Criteria	X			Issue was voted on and approved 2/2011.
1i	Side structure integrity	Tier I Alt Compliance Criteria	X			Issue was voted on and approved 2/2011.
1j	Truck attachment	Tier I Alt Compliance Criteria	X			Issue was voted on and approved 2/2011.
1k	Interior fixture attachment	FRA proposed a 5g/3g/3g requirement applicable for all interior fixture attachments. <u>Industry</u> to evaluate the 5g/3g/3g requirement against current designs and advise of issues that would lead to redesign, significant weight increase, etc.			6/16 – 6/17/11	



11	Seats	<p>FRA proposed compliance to the UK standard GMRT 2100 Issue 4, Draft 1J, June 2008, sections 6.2, 6.3, and 6.9. The FRA advised that it may identify operational considerations in addition to the requirements referenced above.</p> <p><u>Seat Strength Workgroup</u> will continue to hold weekly calls to address the options identified.</p> <p><u>APTA</u> to schedule an “industry only” teleconference to discuss options.</p>			6/16 – 6/17/11	<p>Options being discussed include:</p> <ol style="list-style-type: none"> 1. Adopt GMRT 2100, Issue 4, Part 6.2 (Seats for passengers, personnel or train crew) & associated appendices. <u>Industry</u> to demonstrate equivalent safety. 2. Adopt an alternate approach whereby a crash pulse representative of the crippling of a HSR trainset would be applied to the APTA seat standard parameters for dynamic testing. <p>It was agreed that should GMRT 2100 be used, application of the table and operator requirements within GMRT 2100 would not be included.</p>
2	Passenger-Occupied End Cars	Acceptable to the FRA, using system safety approach with appropriate mitigation in these areas.	X			



3	Interoperability /Compatibility	<p>Interoperability requirements consist of crashworthiness, floor height, carbody width and track-worthiness. FRA feels a range of floor heights and carbody widths are appropriate. Industry has prepared a spreadsheet of candidate HSR trainsets. For width the range is 2.87 m – 3.4 m. For floor height the range is 306 mm – 1300 mm.</p> <p><u>FRA to provide update.</u></p>			6/16 – 6/17/11	<p>Industry provided a spreadsheet of candidate HSR trainsets to the FRA.</p> <p>FRA advised that in lieu of establishing a range of carbody floor height/width requirements, the FRA may defer this decision to the operating entity.</p>
4	Fire Safety	<p>Floor fire tests per current CFR of 15 min minimum (Appendix B to part 238), with the agreement in principle that the floor structure can be tested with the underfloor mounted side shrouds and underfloor cover in place, as illustrated below.</p> 	X			<p>Consensus reached in principle on 3/30/11, that this is an acceptable alternative approach.</p> <p>For external fuel source – test to ASTM E119 – consider full assembly (floor, shroud, underfloor cover)</p> <p>For internal fuel source (between underfloor and underfloor cover) to be addressed in fire hazard analysis.</p> <p>Issued voted on and approved on 3/30/2011</p>



5	Emergency Evacuation	(a) Window Access: Pull out glazing strip or international practice of breakaway glazing. International practice acceptable with proper signage and may need to have input on location and hammer design. Size of windows must either be as per current CFR or must have an equivalent emergency egress plan approved by FRA. (b) Emergency Door Release: No changes to current CFR.	X			Consensus reached 2/15/2011.
6	Forward-Facing Cab Glazing	Tier II glazing required for cab, testing to occur at installed angle. Industry to prepare statement that reflects approach presented at the March 2011 meeting, and provide update based on discussions with Union representatives.			6/16 – 6/17/11	Industry proposed modifying the CFR Tier II requirements (i.e. reduce mass of projectile) that would result in a comparable amount of kinetic energy produced using the EN 15152 method. Industry presented energy associated with Tier I, II, and III impacts at track speed. (Solid sphere with a maximum diameter of 125 mm). Optical clarity crucial for safe operations. FRA is agrees in principle but is awaiting confirmation by the Union representatives.
7	Side-Facing Cab Window Glazing	Type I glazing for cab side windows.	X		6/16 – 6/17/11	Industry accepts FRA request for side Type I glazing in cab side windows. This will be voted on in conjunction with the forward-facing cab glazing requirements.



8	Emergency Lighting	Compliance with APTA standards for low-level exit path marking, and CFR for lighting requirements.	X		6/16 – 6/17/11	This will be fully approved when the interior fixture attachment strength requirements are resolved.
9	Luggage Retention	<p>Overhead racks could remain open storage as long as there is a separate space for larger items. Industry to help define retention standards for luggage.</p> <p>Per FRA's request, APTA has forwarded a luggage retention survey to several HSR operating agencies.</p> <p>APTA to send a follow-up email to HSR operators.</p> <p>Frank Banko will compile responses and present findings.</p>			6/16 – 6/17/11	<p>Industry proposed language for overhead storage and luggage racks.</p> <p>FRA advised that it will consider the proposed language and may propose criteria for height of the retention edge for overhead luggage racks. FRA also advised that it may propose a requirement for the trainsets to have a dedicated area for large luggage/parcels.</p> <p>Interior fixture attachment strength needs to be resolved.</p>
10	ADA Compliance	Item removed from ETF agenda				



11	Side facing windows (non-cab)	<p>FRA proposed Type II (49CFR223) requirements for side facing windows.</p> <p><u>FRA</u> will identify maximum quantity of breakable side facing emergency access windows.</p>	X			<p>Issue was voted on and approved on 3/31/11.</p> <p><i>Industry to advise if side facing emergency windows can withstand Type II impact requirements. If not, what level of energy can be withstood.</i></p> <p>Industry requested FRA to provide test criteria for Type II glazing per 49 CFR Parts 223 as proposed by the RSAC Glazing task force.</p> <p>Industry would like to work with FRA and get rid of the cinder block test for standard windows.</p> <p>Industry accepts the energy values required, but need to refine the projectile size and mass for a repeatable test.</p>
12	PTC	PTC systems required by FRA. FRA working with train control industry to seek what systems exist that meet the FRA PTC requirements (e.g. prevent collisions, overspeed derailments, protect roadway workers, protect against switches in wrong position), <u>and</u> initiate steps to achieve type approval.	X			FRA advised that PTC engineers were scheduled to go to Europe to evaluate PTC systems. This trip was cancelled due to budgetary constraints. FRA will work with industry to gain familiarity with train control systems, and will re-schedule trips ASAP.



13	Brake systems	<p>FRA will address as technology develops within projects. FRA wants to know how the system works, maintained etc. FRA provided list of brake system requirements. Industry to review braking system requirements.</p> <p><u>Industry to develop draft performance-based braking requirements to be distributed to the group prior to the next ETF meeting.</u></p> <p><u>APTA to establish a working group with input from European and Asian manufacturers to document the different types of braking systems and related performance.</u></p> <p><u>Industry to review existing regulations and identify brake system design, inspection, and maintenance requirements appropriate to Tier III trainsets.</u></p>			6/16 – 6/17/11	<p>FRA provided a listing of applicable CFR's.</p> <p><u>Industry</u> to review and advise of any issues relative to current HSR trainset designs.</p> <p>Industry advised that the existing regulations are being evaluated. There are existing regulations that are not be applicable to Tier III trainsets.</p>
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14	Track worthiness	<p>FRA advised that HSR bogies need to be able to operate over Tier I territories (Track Class 1 – 5). Industry agrees that track upgrades may be required. Limits of track to be recommended by Industry for operation with HSR trainsets. FRA is not requiring bogie redesign. Requirement to focus on track-worthiness. To be addressed as technology is being selected.</p> <p><u>Industry to compile bogie design criteria relative to wheel unloading. Prepare presentation illustrating the performance characteristics of current HSR trainset bogie designs. Industry to provide wheel unloading characteristics.</u></p> <p><u>Industry to advise if existing HSR designs can meet the wheel unloading requirements contained in APTA SS-M-014-06.</u></p>			6/16 – 6/17/11	
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15	Other	FRA sought feedback from industry on other items to be added to the ETF II agenda.			Discussed Tier III concept, and the progression towards rule making. Requested clarification on approach to rule making. FRA advised intent is to develop a guidance document with formal rule making to follow. FRA advised that the alternative Tier I standards would be codified in the CFR. Industry would petition FRA to use these alt standards. This would not be waiver process, rather a determination by the FRA that the equipment is safe.
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END OF APPENDIX A